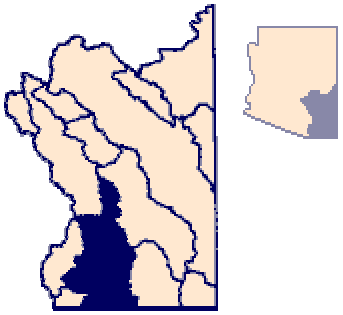
UPPER SAN PEDRO BASIN



The Upper San Pedro basin is in southeastern Arizona and contains approximately 1,875 square miles (Figure 17). The basin, which lies entirely within the Basin and Range physiographic province, consists of the northwest-trending San Pedro River Valley and the surrounding mountains. Elevations along the valley floor range from 4,200 feet above mean sea level at the International Boundary to 3,300 feet above mean sea level at "the Narrows", which forms the basin's northern boundary. The mountains bordering the basin range from 5,000 to nearly 10,000 feet in elevation. The Huachuca, Mustang, Whetstone, and Rincon Mountains form the basin's western boundary and the Mule, Dragoon, Little Dragoon, and Winchester Mountains form the eastern boundary.

The San Pedro River is the basin's major surface-water drainage. The San Pedro River enters the basin at the International Boundary near Palominas, Arizona, and flows northwest for about 62 miles before leaving the basin north of Benson at "the Narrows". The San Pedro River is mostly ephemeral and only flows in response to local rainfall. The river does have a perennial stretch of about 18 miles between Hereford and a point just south of Fairbank. The perennial reach, near Charleston, is created by bedrock that forces groundwater to the surface.

Groundwater is found in two major units in the Upper San Pedro basin: 1) the streambed alluvium that forms the San Pedro River's channel and floodplain, and 2) the alluvial basin-fill sediments that fill the valley. The streambed alluvium is more permeable than the basin-fill, but the alluvium's limited areal extent only makes it an important local aquifer in the central valley along the San Pedro River's floodplain. The alluvial basin-fill sediments, consisting of the younger basin-fill, older basin-fill, and basal conglomerate, form the basin's principal aquifer. Consolidated bedrock found in the surrounding mountains yields only small amounts of water from localized aquifers.

The hydrologic characteristics of the regional aquifer vary widely with the degree of compaction and the extent of fine-grained layers in the basin-fill. The younger and older basin-fill units are generally fair-to-good aquifers and provide the bulk of water pumped from the regional aquifer. Well yields of 100 to 2,800 gallons per minute have been reported from the basin-fill aquifer (Roeske and Werrell, 1973). The basal conglomerate unit generally is tightly-cemented, but where weakly-cemented or fractured by faults, well yields of several hundred gallons per minute have been reported (Roeske and Werrell, 1973).

Groundwater in the basin-fill is found in both unconfined (water table) and confined (artesian) conditions. Depth to water in unconfined areas of the basin-fill in 1978 ranged from 50 to 570 feet below land surface (Konieczki, 1980). Water levels are generally stable in the basin except in the Fort Huachuca-Sierra Vista area where groundwater pumpage has created a large cone of depression (Putman and others, 1988). The cone first was documented by Roeske and Werrell (1973) from data collected in 1968 and was centered in Section 33 of Township 21 South, Range 20 East. Water-level declines within the cone averaged 1.4 feet per year from 1968 to 1986 (Putman and others, 1988). Further hydrologic studies are needed to determine the impact of long-term groundwater withdrawals in the Fort Huachuca-Sierra Vista area on flows in the San Pedro River.

Confined or artesian conditions in the regional aquifer occur near the center of the basin where fine-grained beds restrict vertical groundwater movement. There are two areas where confined conditions are found: one is in the southern part of the basin between Palominas and Hereford and the other is to the north near Benson and St. David. Deep wells drilled in or near the floodplain of the San Pedro River in these areas encounter artesian conditions. The artesian area between Palominas and Hereford is about 10 miles long and one mile wide (Heindl, 1952); the artesian aquifer is encountered in wells drilled deeper than 200 feet (Roeske and Werrell, 1973). Artesian conditions also are found from about six miles south of St. David to Benson in wells drilled deeper than 200 feet. North of Benson, an artesian aquifer is encountered at 500 to 1,000 feet below land surface (Roeske and Werrell, 1973).

The streambed alluvium that occupies the San Pedro River's stream channel and floodplain is very permeable; well-yields range from 200 to 1,800 gallons per minute (Roeske and Werrell, 1973). Groundwater in the alluvium is unconfined, and water levels are usually less than 50 feet below land surface (Konieczki, 1980). The streambed alluvium is recharged primarily by surface-water flows in the riverbed. As a result, water levels in the alluvium seasonally fluctuate in response to surface-water flows in the riverbed: slightly rising in the spring and early summer, then declining in the fall and winter (Page, 1963).

The consolidated bedrock of the mountains surrounding the basin only yield water where sufficiently faulted and fractured. The small, localized aquifers created by these fault zones only provide enough water for stock and low-use domestic wells. Most springs in the bedrock tend to be small and measured discharges vary greatly. The largest springs in the basin are located in the Huachuca Mountains and have discharges as high as 1,800 gallons per minute. However, many of the springs also have periods of very little or no flow (Brown and others, 1966).

Groundwater movement in the basin is from the higher elevations in the mountains towards the valley and then northwest along the riverbed. Groundwater moves readily between the younger and older basin-fill units and between the streambed alluvium and the younger basin-fill unit. In the confined areas, water from the artesian aquifers may leak upwards into the water-table aquifer. The total amount of groundwater in storage in the Upper San Pedro basin is estimated to be 59 million acre-feet (Arizona Department of Water Resources, 1990).

Water enters the aquifers by mountain-front recharge and by streambed infiltration. A smaller amount enters the basin as groundwater underflow from Mexico. Mountain-front recharge consists of surface runoff that flows off the bedrock in the mountains. It infiltrates into the permeable basin-fill sediments on the alluvial fans surrounding the mountains, and eventually reaches the water table. Streambed infiltration occurs when surface-water flows in the San Pedro River channel and its tributary washes infiltrate the coarse streambed sands down to the water table.

Mountain-front recharge is the main source of recharge for the regional aquifer and streambed infiltration is the main source of recharge for the streambed alluvium in the San Pedro River floodplain. Recharge also enters the regional aquifer as infiltration from the streambed alluvium. Direct infiltration of precipitation falling on the valley floor is considered negligible due to high evaporation rates and low rainfall totals (Freethey, 1982). Groundwater recharge estimates are 29,000 acre-feet per year from streambed infiltration and mountain-front recharge, and 900 acre-feet per year from underflow into the basin from Mexico (Arizona Department of Water Resources, 1990). Total groundwater recharge into the basin is estimated to be nearly 30,000 acre-feet per year (Arizona Department of Water Resources, 1990).

Groundwater is discharged from the basin by pumpage from wells, evapotranspiration from phreatophytes and crops, evaporation from open water in the riverbed, and discharge from springs and seeps. Pumpage is the largest source of discharge; in 1988-1989, it was estimated to total 40,300 acre-feet (Arizona Department of Water Resources, 1990). Estimated groundwater pumpage in the Upper San Pedro basin for 1988-1989 is presented in Table 24. Irrigation is a major water user in the basin with approximately 12,700 acres of land irrigated in the basin (Arizona Department of Water Resources, 1990). Most irrigation wells are located in the highly-permeable streambed alluvium. Most industrial and domestic/public supply wells are located in the regional basin-fill aquifer.

TABLE 24
PUMPAGE OF GROUNDWATER IN THE UPPER SAN PEDRO BASIN FOR WATER YEAR 1988-1989

Water Use	Pumpage (ac-ft/yr)
Irrigation	30,380
Public Supply/Domestic	9,460
Mining/Industrial	430
Total	40,270

Source: Arizona Department of Water Resources, 1990

The quality of groundwater in the Upper San Pedro basin generally is suitable for most uses. The total dissolved solids concentrations of samples collected in 1978 (Konieczki, 1980) ranged from 200 to 2,500 milligrams per liter (mg/l). The recommended secondary maximum contaminant level for total dissolved solids in drinking water is 500 mg/l. The dissolved solid concentration in wells is highest in the San Pedro River floodplain from St. David north to "the Narrows".

Fluoride concentrations for well and spring samples collected in 1978 ranged from 0.1 to 5.9 mg/l (Konieczki, 1980). Fluoride concentrations were highest in wells completed in the streambed alluvium along the San Pedro River between St. David and Benson. The maximum contaminant level for fluoride in drinking water has been set by the Arizona Department of Environmental Quality (ADEQ) at 4.0 mg/l.

Known groundwater-quality problems existing in the Upper San Pedro basin include nitrate contamination of groundwater near St. David and sulfate contamination in the Bisbee-Naco area. In St. David, groundwater is contaminated with nitrates, lead, and sulfates (Hargis and Associates, Inc., 1991), potentially due to the operation of a nearby explosive-and- chemical manufacturing firm. The area around Apache Powder Company is now designated as a Federal Superfund site. Site investigation and remedial action have begun under the supervision of the U.S. Environmental Protection Agency, Arizona Department of Water Resources, and Arizona Department of Environmental Quality. Other potential sources of contamination include inadequate septic tank systems and agricultural practices. In the Bisbee - Naco area, the infiltration of leachate from a tailings pond near Warren, northeast of Naco, Arizona, appears to be contributing sulfate to the groundwater (U.S. Environmental Protection Agency, 1988).